Greenhouse Gas Emissions from Grazing Dairy Farms

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Factors Affecting Emissions

- Animal diets
- Type of housing facility
- Manure handling practices
- Crops grown for feed
- Soil characteristics
- Tillage practices
- Climate

Greenhouse Gas Sources

Animals

Manure

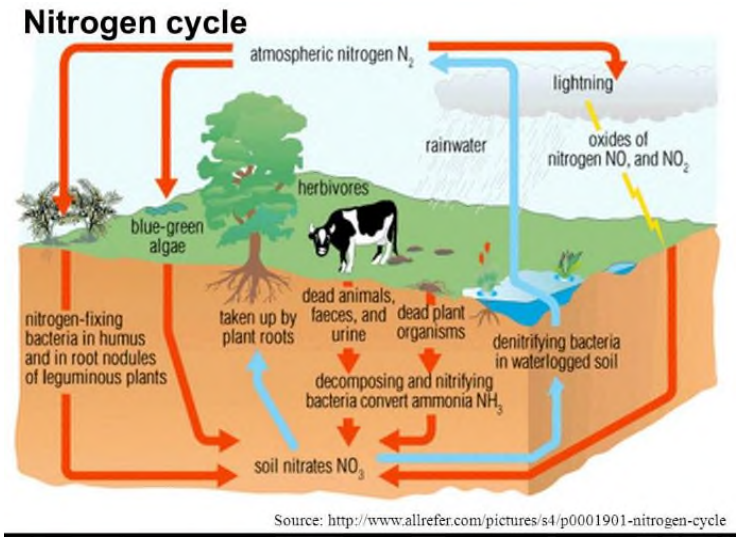
Fuel & lime

Crop and pasture land

Indirect Land

Ammonia emissions

Nitrate losses

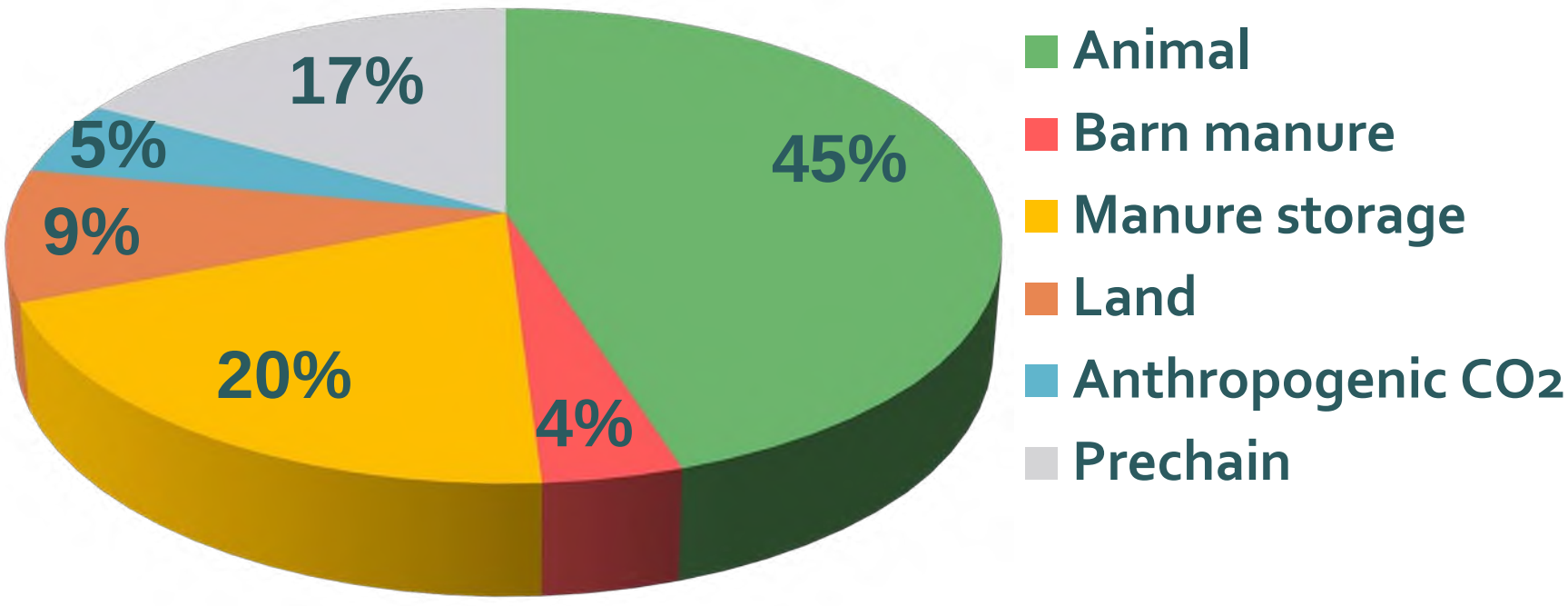


Upstream or Pre-chain

Farm Gate Footprint

0.8 to 1.2 kg CO_2e / kg FPCM

Farm GHG Emissions



Life Cycle Assessment

Upstream

Farm

Transport

Processing

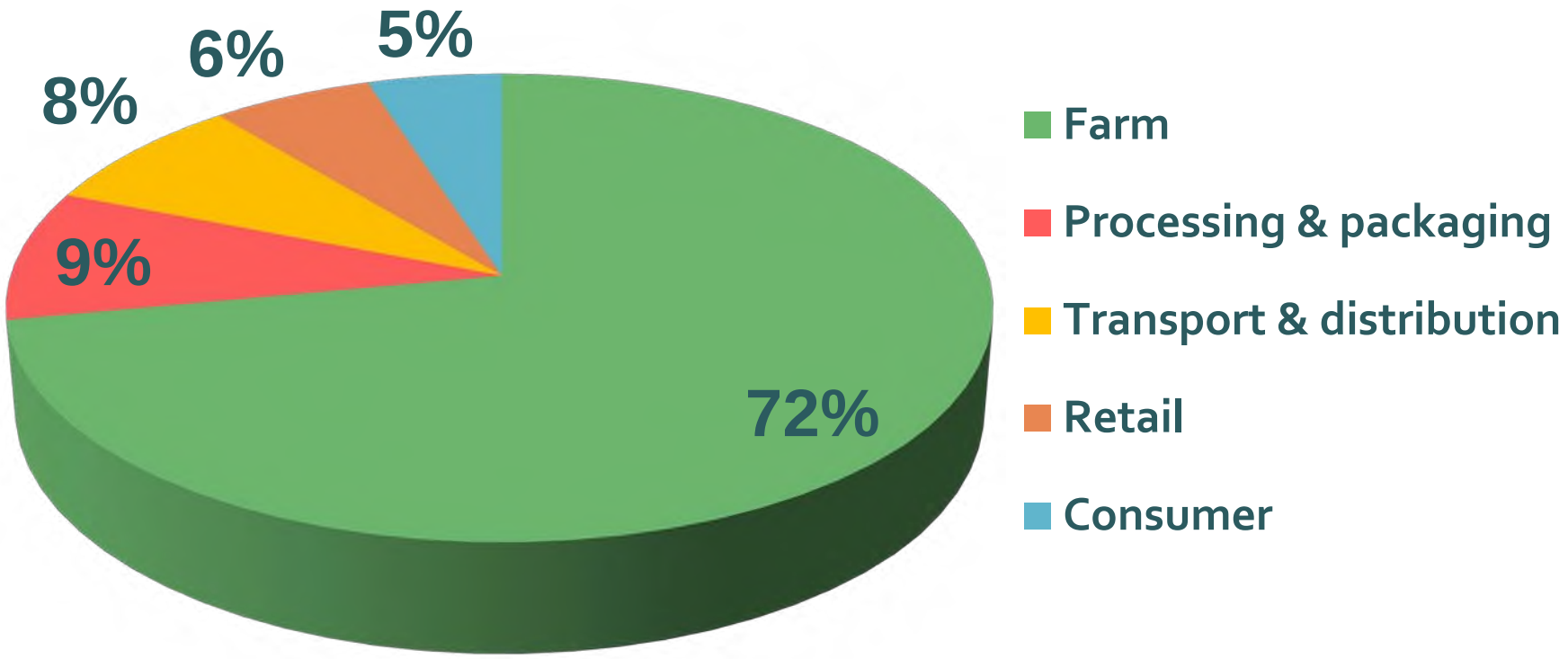
Retail

Consumer

Waste

Cradle-to-Grave Footprint

2.0 kg CO_2e / kg FPCM Consumed

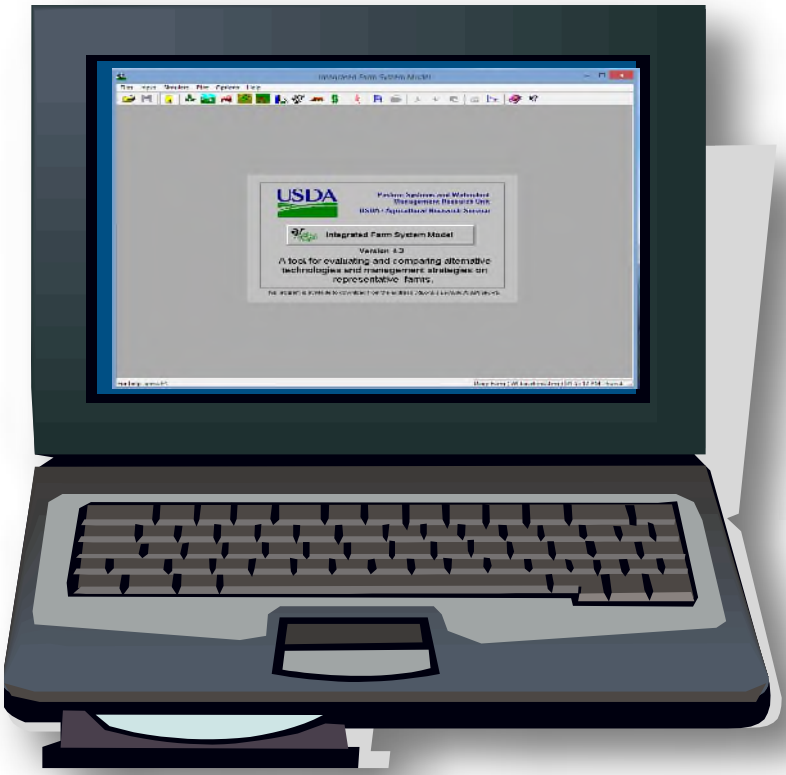


Thoma et al., 2013

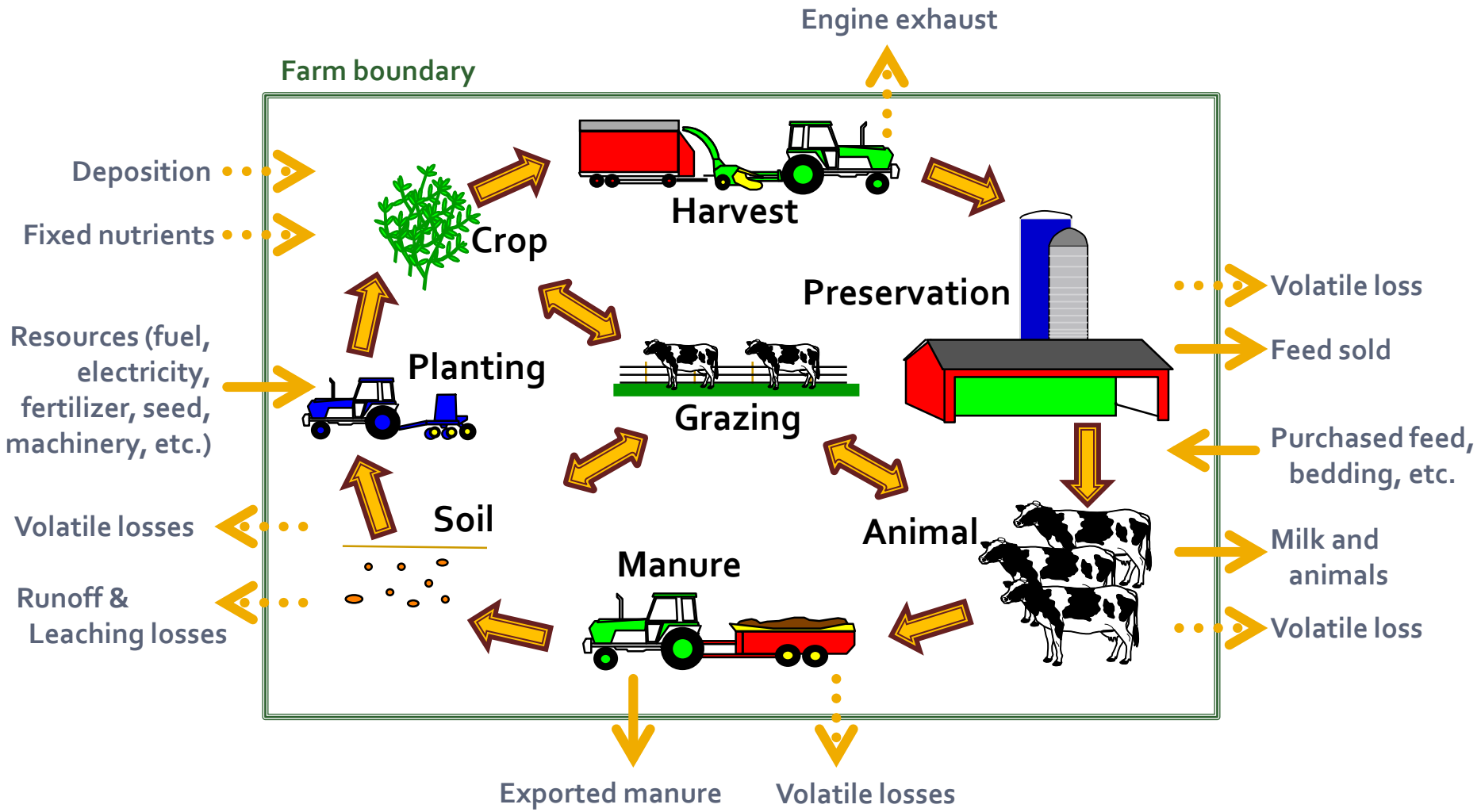
Whole Farm Evaluation

- All sources must be considered
- Interactions occur among emission sources
- Simultaneous measurement of all farm sources is prohibitively expensive and essentially impossible
- Modeling provides a much more feasible approach

Integrated Farm System Model



Process-Level Farm Simulation



Farm Performance

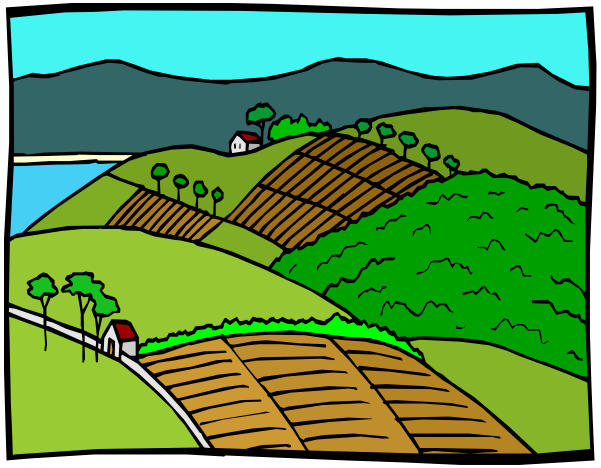
- Crop yields and quality
- Feeds produced
- Feeds bought and sold
- Milk or meat produced
- Manure produced and handled
- Labor, fuel and equipment use

Economics

- Annual production costs (crop production, harvest, storage, feeding, etc.)
- Annual income from milk, animals, and feed sold
- Net return or profitability

Environmental Impact

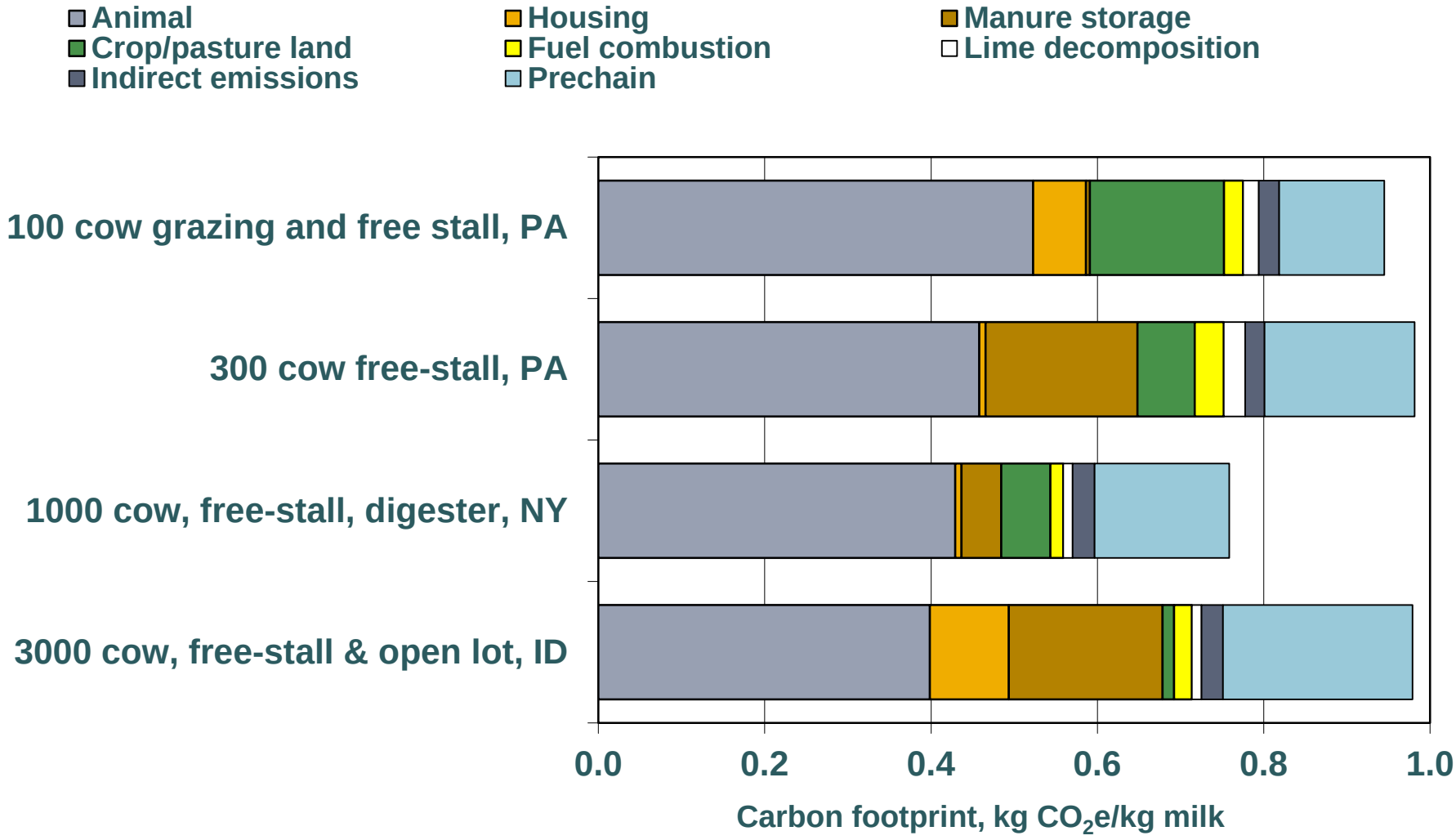
- Greenhouse gas emissions
- Ammonia emission
- Hydrogen sulfide emission
- VOC emissions
- Denitrification N loss
- Leached N and N concentration in groundwater
- Erosion, soluble and sediment P runoff losses
- N, P, K and C balance



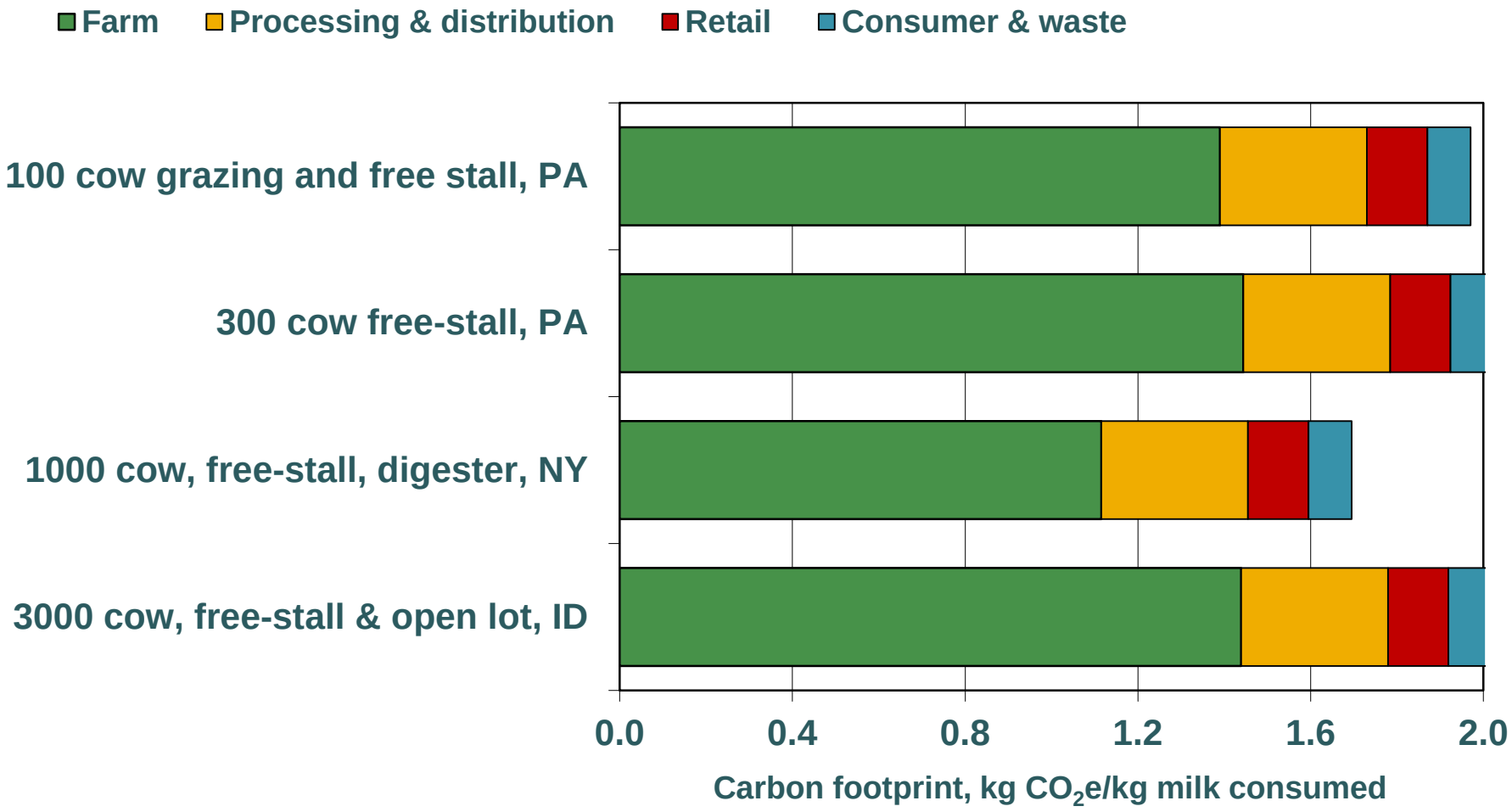
Dairy Production Systems

- 100 cow (8,400 kg milk/cow) tie-stall & grazing, PA
- 300 cow (10,500 kg milk/cow) free-stall, PA
- 1000 cow (11,360 kg milk/cow) free stall, digester, NY
- 3000 cow (10,700 kg milk/cow) open lot, free-stall, ID

Farm Gate Carbon Footprint



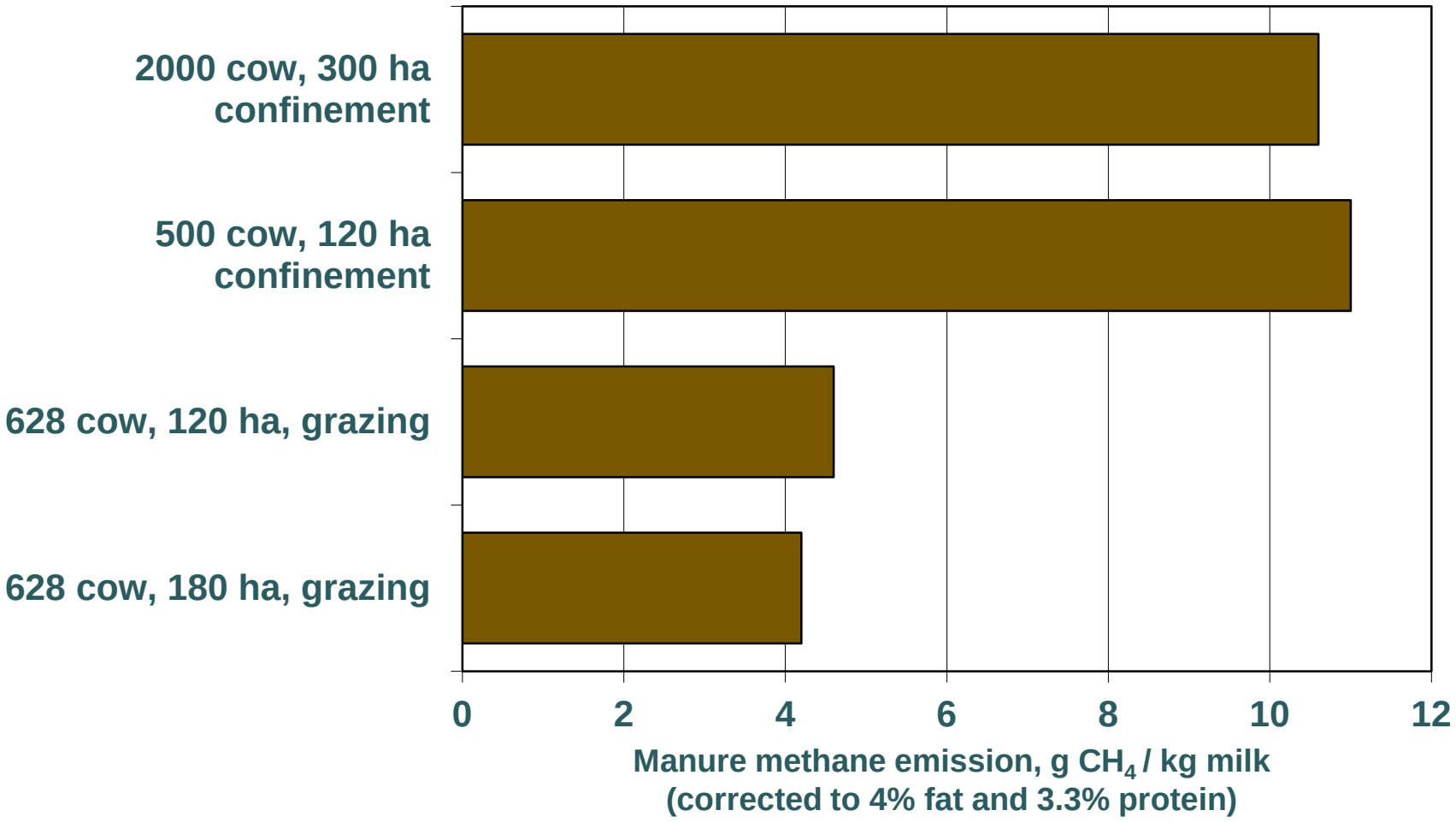
Cradle-to-Grave Carbon Footprint



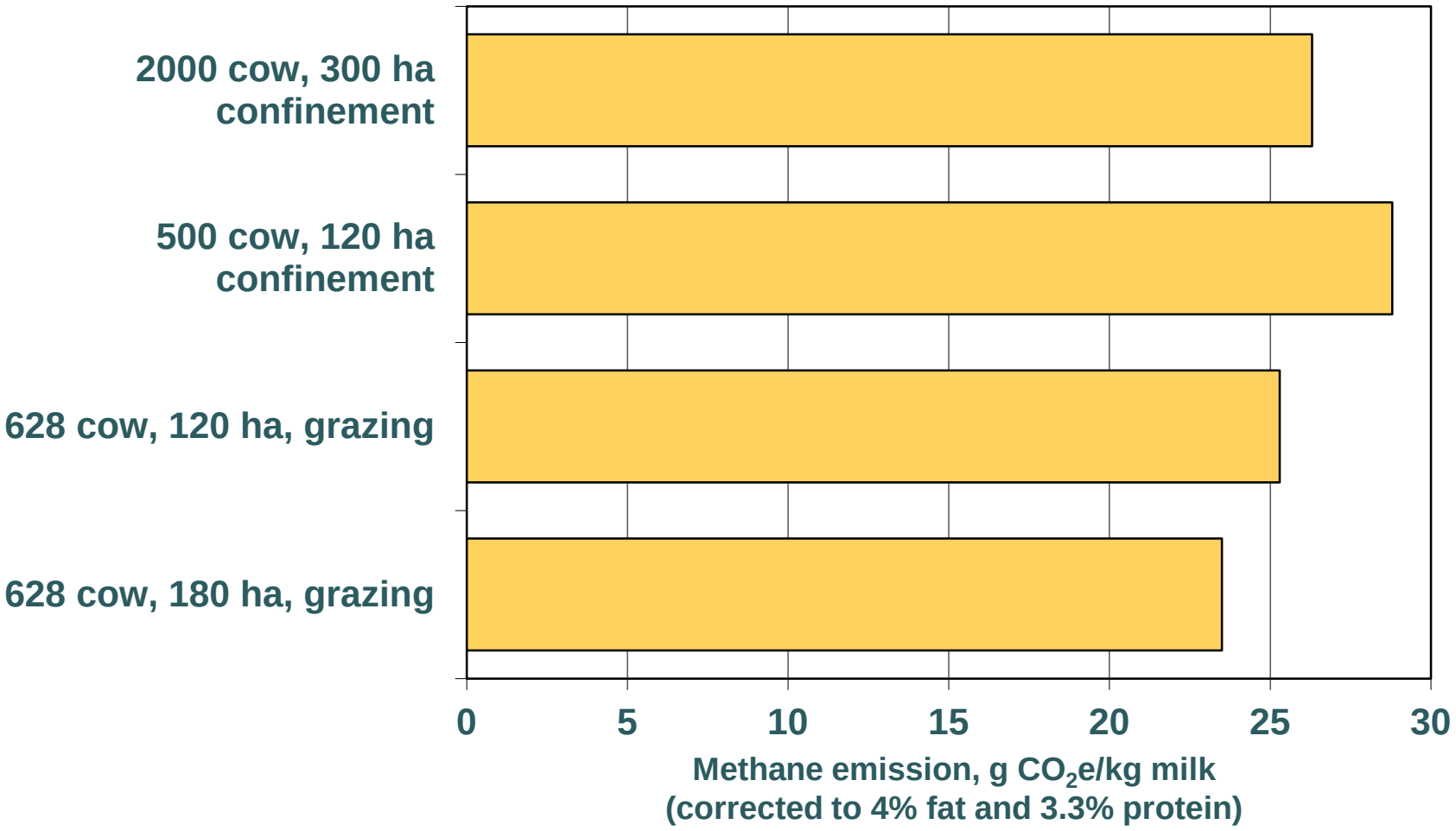
California Production Systems

- 2000 cows, 11000 kg milk/cow (3.5% fat), 300 ha, double crop of corn and small grain silage, full confinement
- 500 cows, 11000 kg milk/cow (3.5% fat), 120 ha, double crop of corn and small grain silage, full confinement
- 628 (smaller) cows, 8800 kg milk/cow (3.8% fat), 60 ha double crop of corn and small grain silage, 60 ha pasture
- 628 (smaller) cows, 8800 kg milk/cow (3.8%), 90 ha, double crop of corn and small grain silage, 90 ha pasture

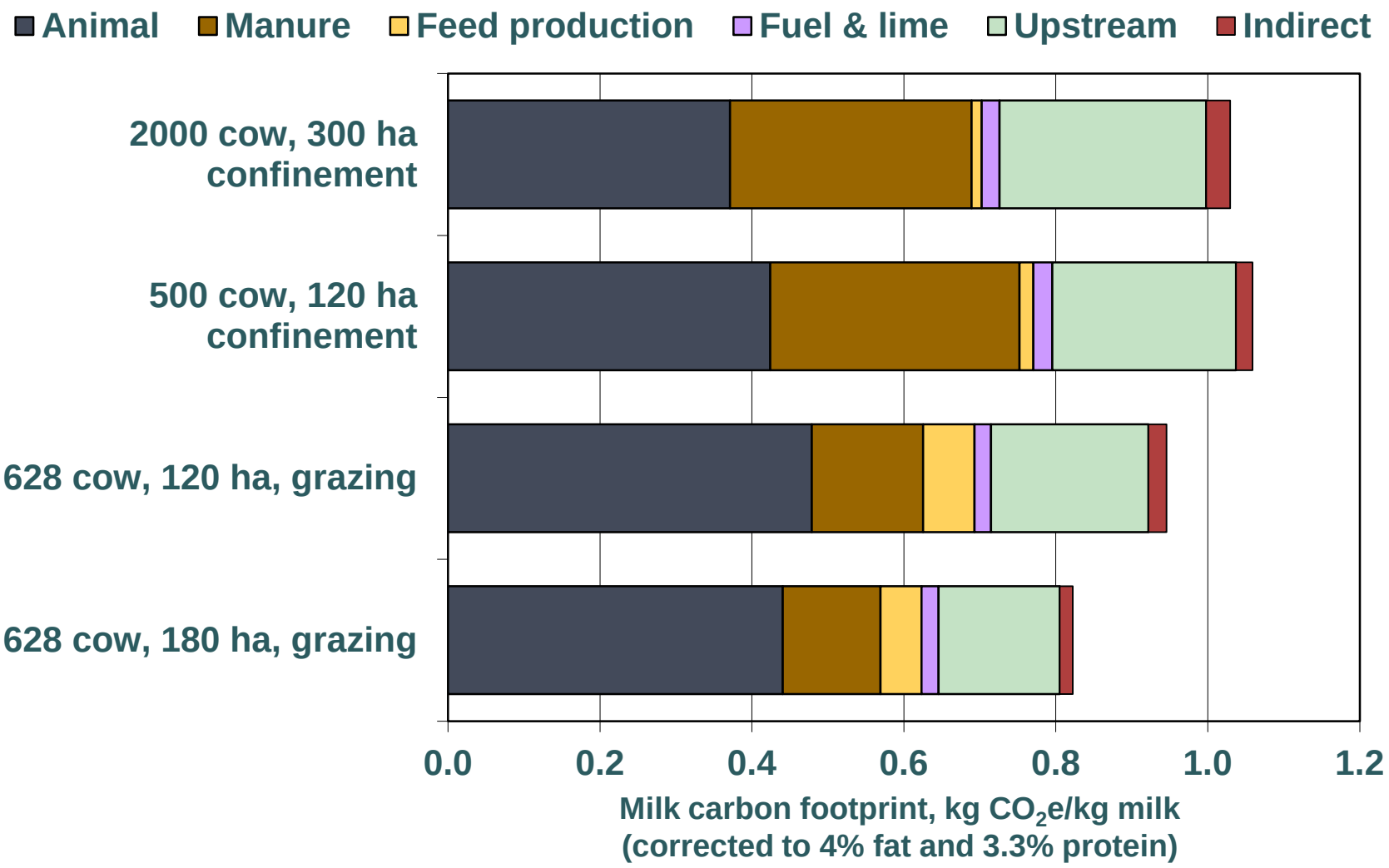
Manure Methane Emission



Total Methane Emission



Carbon Footprint



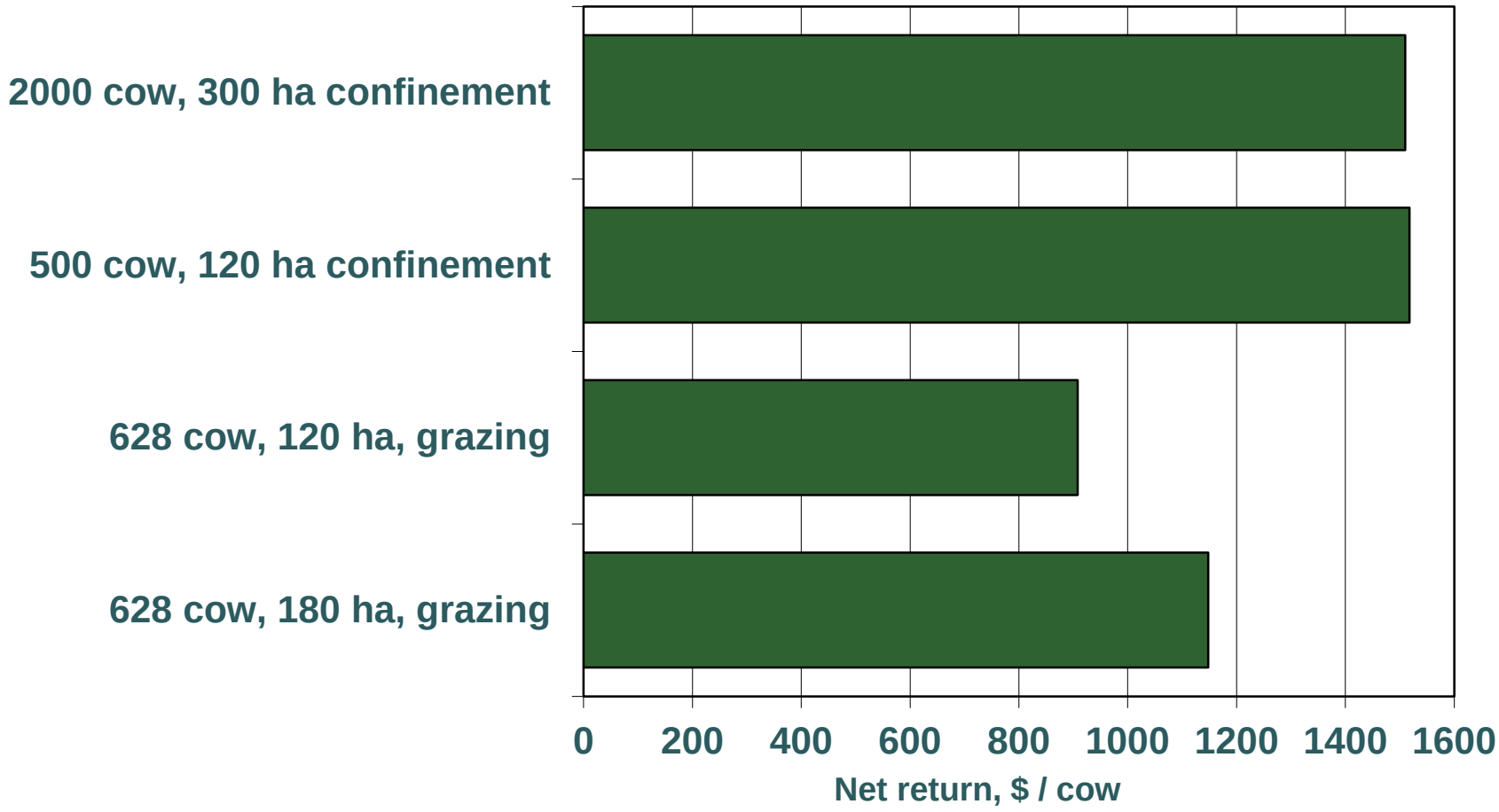
Carbon Sequestration

- Soil always seeks a carbon balance
- Sequestration only occurs following a major change in crop or tillage management (row crop to perennial grass)
- During a transition period, GHG emissions may be reduced up to 20%

Carbon Sequestration

- In the transition from cropland to pasture, carbon sequestered can be 0.25 to 1.25 Mg C/ha/year (Alan Franzluebbers)
- For our farm, this is .011 to 0.057 kg CO_2e/kg FPC milk
- Or 2 to 10% reduction in carbon footprint

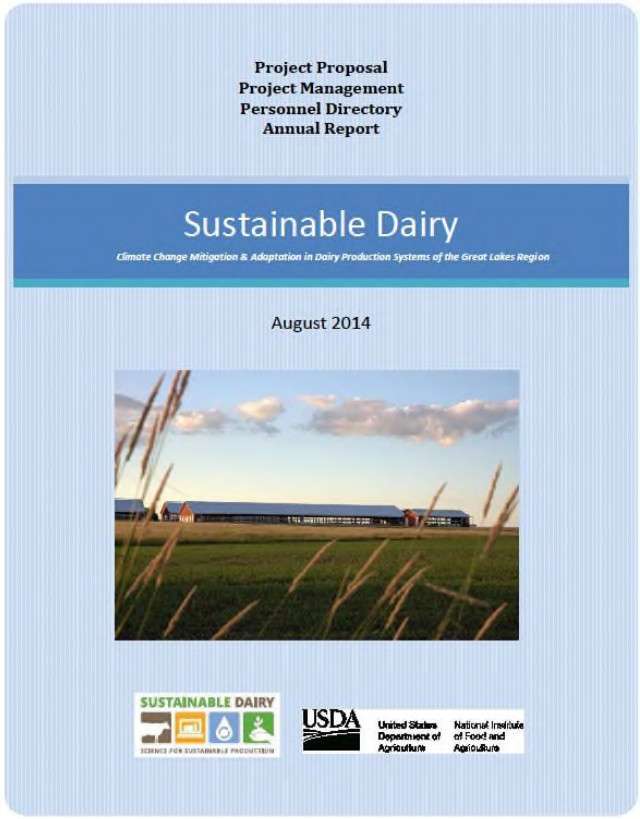
Net Return Per Cow



Net Return Per Land Area

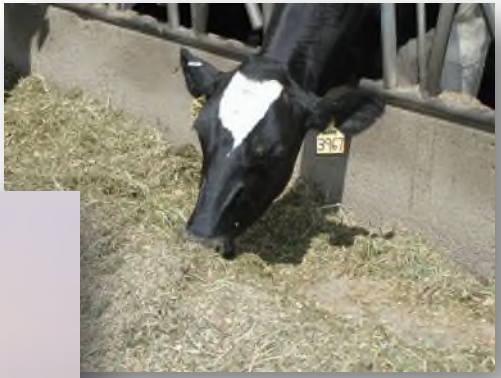
Sustainable Dairy

- NIFA funded, multistate CAP project
- Quantifying GHG emissions from dairy farms
- Exploring BMPs for mitigation
- 1500 cow New York farm and 150 cow Wisconsin farm

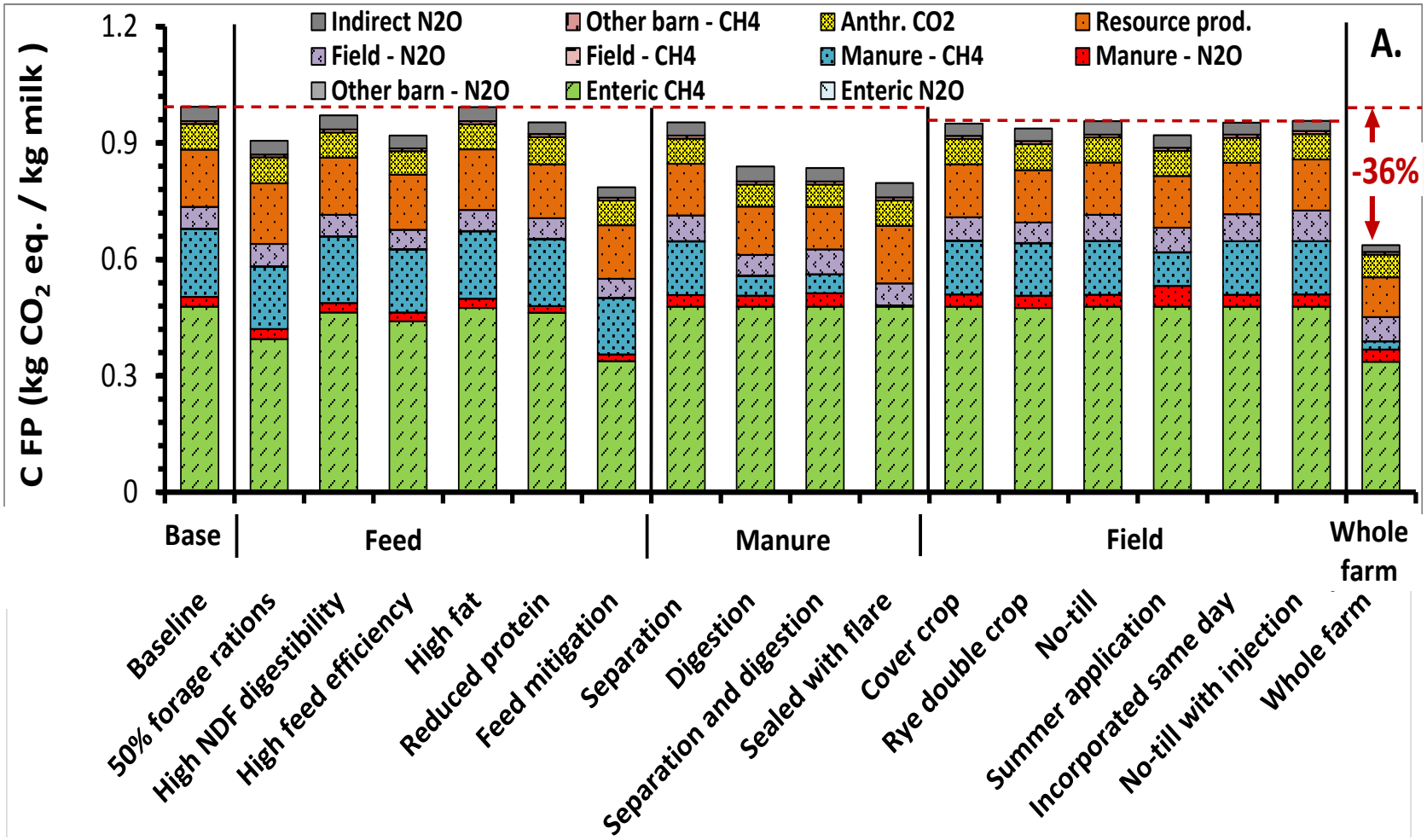


Mitigation Analyses

- Feeding strategies
- Manure management
- Field operations



Carbon Footprint



Conclusions

- Methane contributes about two-thirds of the total GHG emissions of California dairy production systems with about half of this from manure
- An integration of all GHG emission sources should be used to evaluate and compare dairy production systems
- Use of grazing can reduce the carbon footprint of milk produced on a California dairy
- Use of grazing will reduce the milk produced per unit of land area
- Use of grazing will greatly reduce the profitability of milk production in California

Agricultural Research Service

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